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ABSTRACT

This report reviews the Elementary Mathematics Testing Project of Alberta, Canada. The program attempted to determine the effectiveness of the elementary mathematics program using tests based on the program objectives. The project was carried out in Northern Alberta (Zone 1) during the 1978-79 school year. The revised mathematics curriculum, introduced in 1977, presents the mathematics content within five "strands" of Number, Operations and Properties, Measurement, Geometry, and Graphing, at all 6 elementary grade levels. Metric measurement, decimal fractions, and motion geometry are among the program's most prominent components. Criterion-referenced mathematics tests were designed to assess pupil understanding of specific content objectives, with the Zone One Testing Project centering on 5 specific questions related to the new mathematics program and applications of the test results. A variety of conclusions from the tests are given in this report, along with uses of student profile computer print-outs that were a product of the study. The paper concludes with implications of results of the study for the mathematics curriculum and several recommendations for further research. (MP)

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ZONE 1

ELEMENTARY MATHEMATICS TESTING

PROJECT

To

ALBERTA EDUCATION

PLANNING AND RESEARCH

MARCH, 1980

A.L. ANDERSON, Ph.D.

OCT 6 1980

ACKNOWLEDGMENTS

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A special thanks to Curriculum, Field Services, and Planning and Research for their interest and support in the testing project.

Finally, the work of the teachers and administrators from the 141 schools is sincerely appreciated. The hours of testing, correcting, and transferring of data came at a very busy time of year.

INTRODUCTION OF THE STUDY

Background to the Study

In recent years there has been an increasing amount of criticism of the mathematics curriculum that reflects both school and public disillusionment with the mathematics that each has come to know.

The gist of public criticism appears to center on the notion that "children are unable to solve the problems of everyday life."[1] What has resulted are cries for "back to basics" and the assessment of minimum competencies.

Schools, still disappointed with the "new mathematics," were undoubtedly skeptical with the latest elementary mathematics program introductions which delved into such aspects as objective based content, minimum skills, and success centered learning. This was likely the case for the revised mathematics curriculum which was introduced into Alberta schools in 1977. Besides presenting the mathematics content in objective form within the five strands of Number, Operations and Properties, Measurement, Geometry, and Graphing at the six grade levels, this program included additional changes that would add to the implementation difficulties. Metric measurement with an accompanied readjustment to the decimal-common fraction component, motion geometry, and the introduction of graphing

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[1] D. Rappaport, "The New Math and Its Aftermath," Education Digest, 42(5):6-9, January, 1977.

were the most prominant inclusions. Also, with the revised program in place concerns were being expressed about the mismatch of the program of studies objectives and the currently used standardized tests.

To alleviate this latter concern a test development project was initiated under the co-direction of the Grande Prairie School District and the Regional Office of Education in Zone One. Criterion-referenced mathematics tests for grades one to six were designed for the purpose of assessing pupil understanding of the specific content objectives in the new program. These tests were to serve as the data collecting instruments for the Zone One Testing Project research. Such a study was also of interest to Curriculum and Field Services personnel, the topic here being the progress of implementation.

Statements of the Problem

The Zone One Testing Project centered on the following problems in particular.

Firstly, to what extent were students in grades one to six demonstrating achievement of the mathematics objectives as outlined in the 1977 program? Secondly, would there be any significant changes in the proportion of students reaching desirable levels of achievement between the 1978 and 1979 testing? Thirdly, what would teachers attribute low achievement scores to? Fourthly, what would the influence of early versus late starters and male versus female be on the student achievement? Finally, could computerized print-outs of individual students' school and system results be utilized effectively for diagnostic and management purposes?

DEFINITION OF TERMS

Criterion-Referenced Measures

Criterion-Referenced Measures are those test measurement scores which are used to determine individual pupil status with respect to each mathematics objective in the Alberta Elementary Mathematics Program. The individual student is compared with the established criteria related to the specific program objectives rather than with other students.

Criterion Scores

Criterion scores in this study refer to the achievement levels that collective groupings attain in order to be classified as being within one of the four achievement categories (e.g. Category D: 85-100).

Achievement Categories

The population of students within each grade were grouped into one of four achievement categories on the basis of their mean score attainment on each objective. Category A: Below 50%; Category B: 50%-64%; Category C: 65%-84%; Category D: 85%-100%.

Early Starters

Early starters were those students who have entered grade one younger than 6.0 years of age as of September 5. One year was added for each subsequent grade so as to designate the early starters in grades two through six.

Late Starters

Late starters were those students who have entered grade one older than 6.0 years of age as of September 5. One year was

added for each subsequent grade so as to designate the late starters in grades two through six.

Zone One

Zone One of the province of Alberta is that area designated as the northern region as shown in Figure 1.

RESEARCH DESIGN

Pilot Testing

The Zone One Testing instruments, criterion-referenced to the Alberta Program, were piloted in the Grande Prairie public schools in January through March of 1978. Approximately ten classes per grade were administered semi-finalized editions of the test. Teachers from these schools, using the pilot test data, subsequently helped in the final revisions of the Student Test, Teachers' Guide, and Marking Keys prior to the printing and distribution of the tests for the total zone.

Data Collection

Meetings were scheduled with supervisory personnel throughout the zone prior to the 1978 test administration. Various aspects of the project such as the purposes for and the design of tests and the details of administration were discussed because each jurisdiction was to handle their own distribution and school administration. Special forms were designed so that individual student results could be stored for computer analysis. Teachers both marked the tests and transferred scores on these computer forms. The 1978 form (Appendix A) required key punching, while the 1979 form (Appendix B) allowed for machine scoring.

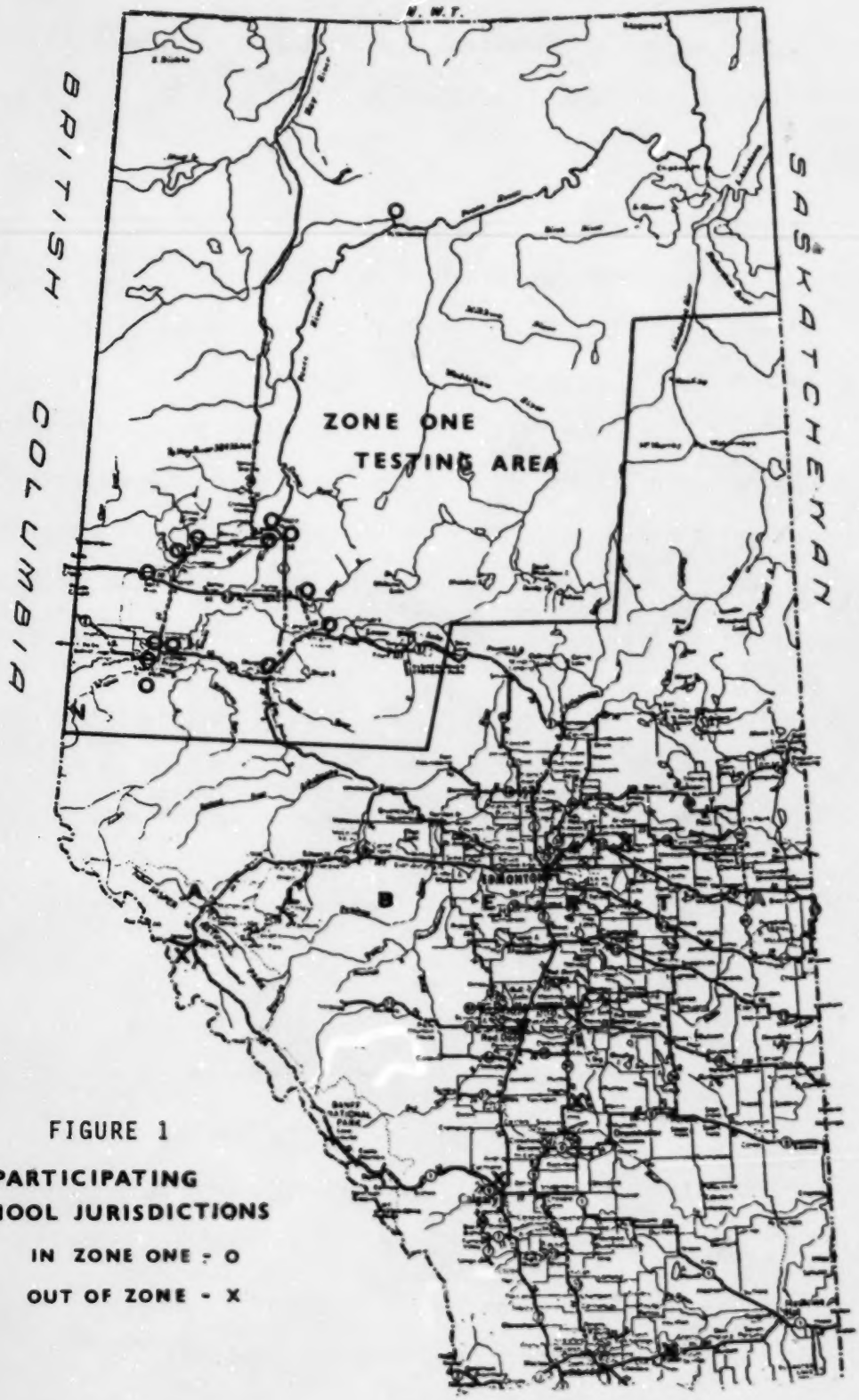


FIGURE 1

PARTICIPATING SCHOOL JURISDICTIONS

IN ZONE ONE - O

OUT OF ZONE - X

Additional information such as student name, sex, school, and system codes and the designation of early and late starters were recorded.

Scoring Reliability

Six student test papers from each of grades one, three, and six were randomly selected from each of four elementary schools in the Zone for the purpose of checking the variability of teacher scoring. Each of the 24 test papers for grades one, three, and six were marked by the researcher according to the same answer key descriptions used by the Zone One teachers who originally scored the papers. Pupil marks, according to both teachers and researcher interpretation, were totaled and averaged for each of the grade levels sampled.

Table 1

Comparing Teacher and Researcher Scoring of Twenty-Four Sample Tests in Each of Three Grades

	Average Pupil Test Score		
	Grade I	Grade III	Grade VI
Teacher Scoring	89	308	150
Researcher Scoring	89	307	148

Figures in Table 1 indicate that teacher and researcher interpretations of the answer keys were not appreciably different.

Data Analysis

A computer program that collected test item scores and matched them to the specific mathematics objectives they were validated to measure was devised by the Division of Educational

Research Services at the University of Alberta. This program was designed to report student achievement on objectives in percentage terms by strand and grade level. Individual student percentage scores were also grouped to form composite percentage averages by schools, school system, total zone or out-of-zone categories. A typical individual student analysis of the 1978 results is shown in Table II. Classroom teachers received these forms.

Table II

A TYPICAL STUDENT PROFILE

I County of G.P.# 1 Beaverlodge Elementary
Student ID 10724 Grade Four (Tac to Analysis Form) June/78

Number	Operations & Properties	Measurement	Geometry	Graphing
1 25.0%	1 50.0%	1 60.0%	1 100.0%	1 100.0%
2 30.0%	2 37.5%	2 20.0%	2 100.0%	2 100.0%
3 100.0%	3 77.8%	3 33.3%	3 42.9%	3 100.0%
4 100.0%	4 40.0%	4 100.0%		4 75.0%
5 100.0%	5 60.0%	5 50.0%		
6 100.0%	6 38.9%	6 0.0%		
7 0.0%	7 25.0%	7 100.0%		
8 0.0%	8 50.0%	8 50.0%		
9 100.0%	9 22.2%	9 25.0		
	10 100.0%			
AVG. 61.7%	50.1%	48.7%	81.0%	93.8%

A typical computer report on one of the 173 objectives of the Elementary Mathematics Program is displayed in Figure 2. Section 1 of the analysis in this figure shows the percentage of students achieving in each of the four criterion levels for both 1978 and 1979. A proportions test was used to determine whether or not student achievement within the two years was significantly different.

A one-way analysis of variance test was the statistical procedure used to test for significant difference between 1978 and

1979 composite performances (mean scores) of Zone One pupils in each of the five strands, grades one to six. This same test was used to test for difference between the mathematics performances of early versus late starters and male versus female pupils.

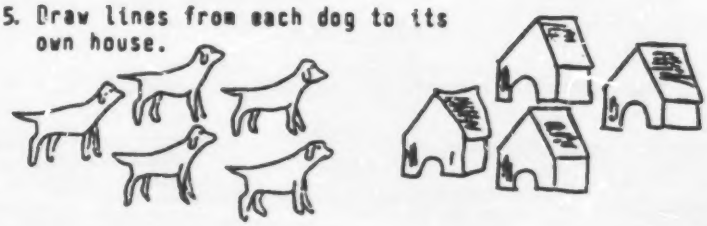
LEVEL A (Grade 1)

NUMBER

OBJECTIVE 1 *Matches members of two sets and determines equivalent and non-equivalent sets.*

TEST ITEMS

5. Draw lines from each dog to its own house.



6. Do all the dogs have houses? Circle yes or no.

Yes No

ANALYSIS

ZONE ONE PUPILS IN 1978 AND 1979 ACHIEVING WITHIN EACH CATAGORY A-D
CRITERION CATEGORIES FOR GRADE:1 STRAND:1 OBJECTIVE: 1
TOTAL NUMBER OF PUPILS: 1978 N=2126 1979 N=1846

	A: BELOW 50%		B: 50-64%		C: 65-84%		D: 85-100%	
	1978	1979	1978	1979	1978	1979	1978	1979
NUMBER(%)	3.10	3.79	7.90	8.18	0.24	0.49	88.76	87.54
MEAN (%)	0.51	0.0	50.00	50.00	80.00	81.48	100.00	00.00

TABLES COMPARING 1978 AND 1979 MEAN SCORES AND PROPORTIONS

	PROPORTION TEST			#	F-TEST					
	HO: PROPOR78=PROPOR79			#	SS		DF			
	T-CALC	DF	PROB	#	BETWEEN	WITHIN	BETWEEN	WITHIN	F-RATIO	PROB
A:	-1.189	3970	0.235	#	8.67	1094.28	1	134	1.061	0.305
B:	-0.321	3970	0.748	#	<<<<<<<<<<<<<< SSW IS EQUAL TO ZERO >>>>>>>>>>>>>>					
C:	-1.338	3970	0.181	#	7.05	469.14	1	12	0.180	0.679
D:	1.186	3970	0.236	#	<<<<<<<<<<<<<< SSW IS EQUAL TO ZERO >>>>>>>>>>>>>>					

COMPARING THE MEAN SCORES OF PUPILS WITHIN ZONE SUBGROUPS

GROUPS	YEARS		#	F-TEST TABLE					
				SS		DF			
	1978	1979	#	BETWEEN	WITHIN	BETWEEN	WITHIN	F-RATIO	PROB
EARLY	93.10	92.62	#	139.68	1162342.40	1	2478	0.298	0.585
LATE	92.57	90.67	#	1168.80	683134.83	1	1300	2.224	0.136
MALE	93.43	91.41	#	2116.49	1003435.85	1	2074	4.375	0.037
FEMALE	92.35	92.72	#	62.38	928589.13	1	1894	0.127	0.721
NORTH	92.52	92.17	#	32.94	551388.73	1	1074	0.064	0.800
SOUTH	93.07	91.98	#	853.45	1381871.77	1	2894	1.787	0.182
PUBLIC	92.72	92.38	#	50.08	1846679.86	1	3164	0.184	0.668
SEPARATE	93.73	90.74	#	1803.03	386544.02	1	804	3.764	0.053

FIGURE 2

Analysis of the Questionnaire

In November, 1978, a discussion paper on the topic of mastery learning as a possible answer to the achievement difficulties in the elementary mathematics program was distributed to all schools in the Zone. The purpose of the paper was to provide a basis for a questionnaire which was included for each teacher. This questionnaire gathered the perceptions of individual teachers relative to the mathematics performances of Zone One students and of their concerns with mathematics program in general.

The Pearson-Product Moment Correlation Coefficient was the statistical analysis used for the marking sections of the questionnaire (Appendix C). The intent was to determine if years of teaching could be used as a predictor for teachers choosing particular factors that could influence achievement.

A series of Eta-Squared tests were used for the analysis of part III of the questionnaire which was not a ranking item. Still the test will determine whether or not teaching experience can be utilized to predict the likelihood of teachers choosing specific reasons for low achievement.

Reporting Results

Computerized print-outs that contained the achievement in mathematics of individual pupils (Table II), the composite scores of students within each school, each school system, and total zone were provided. Jurisdictions did not receive each other's forms although all were given print-outs showing total student populations, male-female, and early and late achievement profiles of each grade level, both for in and out-of-zone participants. An exemplar report of the

data from over 15 000 grades one to six students, in each of the two years of study, is included in Appendix D.

Results from the Study

The primary concern of the study was the mathematics achievement levels of pupils in 1978 and 1979.

Question 1 was "what proportion of the pupils in the zone would be able to achieve within the 85-100 percent level in 1978 and 1979 for each of the objectives in the Number, Operations and Properties, Measurement, Geometry, and Graphing strands?" An eighty percent proportion of students was considered highly desirable.

Results indicated that indeed few objectives had eighty percent proportions of students achieving within the highest (85-100 percent) category. Achievement in the Zone was such that the number of objectives for which eighty percent proportions were recorded decreased with the grades. Grade one had 6 out of 18 such proportions; grade two had 4 out of 28; and grade three had 2 out of 33. Only one such proportion was found throughout the whole of Division II (95 objectives).

Question 2 was "what was the increase in the proportions of students achieving within the 85-100 percent category between 1978 and 1979?" In fact, significantly higher proportions of students in the zone did reach the 85-100 percent category in 1979 over 1978. In Division II, where there was more room for improvement, the gains were greater. For example, of the 79 objectives at the primary level, 34 had significantly more students in the higher category for 1979. Of the 95 objectives in Division II,

69 had significantly higher proportions achieving in the 85-100 percent range.

Question 3 was "what were teacher perceptions of student achievement and the mathematics program in general? (See Appendix C).

According to Zone One teachers, the pupils within their respective school districts failed in their attempts to reach the highest achievement category (85-100 percent) for two equally popular reasons. They suggest that the problems arise because the textbooks that are currently authorized do not match the program objectives. Teachers also say that pupils have inadequate learning skills to enable them to master the program. In other words, they suggest that the primary difficulties lie with the pupil and the materials from which they are required to teach.

Teaching experience was not a reliable predictor of how teachers chose the various factors.

The factors that teachers thought were least likely to be responsible for the low proportion of students in Category D (85-100 percent) were varied. Grades one and two teachers said that neither the program nor the text difficulty would be at fault. Grade three teachers chose the sequencing of content in the textbooks and keeping track of students' performances and follow-up as the least likely factors. Division II teachers collectively agreed that neither the problems associated with keeping track of students' performances nor the difficulty of the program should be responsible for the lack of achievement within the 85-100 percent level.

The two most popular factors that teachers of grades one to six thought would be at work in any good mathematics program

were: first, an instructional plan that would involve good teachable materials, and secondly, a program that could be geared to the ability level of all children.

They considered that grouping children for need, ability, or interest purposes would be of little importance to an effective program. Teachers chose the professional training of instructors as an equally non-important factor.

Another aspect of the questionnaire centered on what teachers thought to be the main causes for the lowest achievement scores within each of the strands. They were to respond in terms of each strand separately but for only one grade which they taught.

The Number objectives related to place value had consistently lower scores on the 1978 tests. Teachers reported that the main reason for students' failure in this area was because they had not mastered the concepts upon which the concept in question was dependent.

Problem solving was the main weakness in the Operations and Properties strand and the most common reason the teachers cited as the primary cause was the same as for place value; that students had not mastered the previous concepts in the hierarchy.

Almost without question the most popular response with regard to the low achievement performances in the Measurement, Geometry, and the Graphing strands was that the topics would not receive the instructional emphasis required for mastery.

Teachers appear to be saying that the Number and the Operations and Properties strands are to be considered the most

important and that the lack of pupil learning within these strands is due primarily to pupil inadequacies.

With regard to the early versus late starters the following results were found. There were few or no achievement differences between students who started school younger or older at the primary level. There were hints of a difference favoring the grade three late starters but the differences were not significant. However, beginning at grade four the late starters significantly outperformed their younger starting counterparts in most strands of the program.

The only area where one sex classification consistently outperformed the other was in the Operations and Properties strand. Here female students did better at all six grade levels. Not only do they do significantly better on the overall strand but also for most of the individual concepts and skills. The one concept area of the strand in which sex difference did not exist was for problem solving. Here both boys and girls had equally low performances.

THE ACHIEVEMENT PROFILES

One of the stated purposes of this investigation was to provide teachers and school supervisors with student achievement results. This was made possible with the design of a computer program which reported the test performances of individual students, schools, and school jurisdictions in relation to the specified objectives of the Alberta Program.

Computer print-outs for each of the above were sent out to the school district offices for distribution. This was completed by the researcher in October of 1978 and in July of 1979.

In addition to the individual student and school print-outs, the supervisors were provided additional data in the form of zone and out-of-zone, male-female, and early-late starter comparisons.

A representative sample of fifteen teachers, five principals, and five central office supervisors was interviewed concerning their utilization of the materials provided. The interview questioning of these individuals had to consider the different procedures that were used for the two years.

The 1978 student print-outs were such that each profile had to be matched with a Student Analysis Form. This was accomplished by a process of matching numbers. Since the forms received from the schools had to be key punched and the analysis program written, the data packages were not sent out to the division offices until October of 1978.

An optically scanned form designed for the 1979 analysis enabled a July shipment of the information to the jurisdictions. These forms had student names printed directly on the profiles so that no matching of forms was required.

The questions asked during the interviews were as follows: "What use, if any, were you able to make of the print-out information you received?" "What were the main strengths and weaknesses of the profiles?" "What added use do you expect to make of the 1979 forms which will include each student's name and also be available for school opening?"

THE USE OF THE PRINT-OUTS

By Teachers

The general conclusion from the teacher interviews was that the computer profiles were not being used as intended.

Originally the print-outs were to be of diagnostic value in terms of indicating individual pupil and class errors. Follow-up teaching could then become more purposeful. Teachers on the other hand appear to be more interested in the comparative use of the materials. They were interested in how their class compared with others from within their system and throughout the zone.

Although the teachers make little diagnostic use of the forms with individual children, they did look at the composite achievement of their students and considered the problem areas as possible reflections on their instructional programs.

The teachers for the most part like the tests but disagreed with the weighting allotted to the various items. They felt that the transferring of marks to the computer forms and Analysis sheets required excessive time. They liked the idea of having the pupil names on the print-outs and thought that better use would be made of these forms.

Teachers also believed that the computer profiles would be utilized to a greater extent if they were available during the year and not after the pupils had moved on to the next grade.

By Principals

The reactions of principals to the computer print-outs were much like those of the teachers. They too were intent on knowing how their schools compared to others. One principal, for example, had drawn a bar graph that showed the performances of his school as compared to the others within his system and with those of the zone.

Few examples of instructional leadership were noted in terms of helping teachers make maximum use of the print-outs at the pupil level, even though discussion of the results was encouraged in most cases.

A majority of the principals attempted to incorporate the student profiles within the cumulative record files. One school, however, had not received the 1978 Student Analysis Forms from the Division Office so it was impossible for him to even identify individual pupils.

A few of the principals and teachers had expressed concerns about the possible use of test information for implicating their competence. This again was a reflection of the emphasis given to comparing test results.

Central Office Supervisors

Use of the profile sheets at the jurisdiction level was as varied as at the school level. The political attitude of "how do we stand?" was also in evidence with the supervisors, although there was generally a high degree of interest in improving student performance.

One supervisor held school meetings concerning the test results in an attempt to generate solutions to perceived instructionally weak areas. Another, however, had forgotten about the Student Analysis Form match-up and they remained in his office.

All supervisors expressed an interest for follow-up work in their schools relative to improving the mathematics programs being offered their children. They also gave support to the concept of student assessment within their schools.

STUDENT ACHIEVEMENT

There is good evidence to suggest that children come well equipped to handle the entry year of the elementary mathematics program. The results indicate that grade one students do experience success. One may even extend this assessment to many areas of the grades two and three program as well. However, pupil achievement in mathematics is relatively low at the Division II level.

Yet many of the difficulties that predominate in grades four, five, and six have their beginning at the primary level. The place value concepts, vitally important to the total program, start their failing trend in grade one. Pupils begin to show a lack of understanding of the processes or actions involved in the operation at the grade one level as well.

Although the grade one pupils demonstrate a high level of recall of the basic facts, the grade two's begin to show a deficiency in this skill. This lack continues throughout the elementary grades and likely hampers some of the opportunities students have for success in other areas. Teachers recognized this weakness in that they considered their students not to have mastery that would allow for the successful achievement of other dependent concepts.

The power of the textbook may be coming out in this study. Certainly the teachers rated it high as a reason for not being able to bring more students within the higher achievement category. How much influence the textbooks have on the achievement at the higher grades is perhaps speculative although there may be some relationships. For example, an investigation conducted by the Ad Hoc Committee found during the development of the elementary program

that the higher the grades, the fewer the program objectives that are being treated in the authorized textbooks.

The problems that students have from grade two and on with regard to the introduction of the new (e.g., multiplication after addition) operations, is likely a shared responsibility of the program, textbooks, and the teachers' handling of the instructional plans. This weakness is evidenced by the achievement figures that show students to have increasing difficulties as the multiplication and division operations are incorporated into the program sequence with addition and subtraction.

The problems associated with the treatment of the operations may be in part responsible for the lack of performance in problem solving. From the time the process is introduced in grade two, through to the grade six level, children do poorly.

The performance on the Metric Measurement seems to deteriorate immediately following the successful introduction of non-standard measurement in grade one. It appears as though the grades four, five, and six students have not had the opportunity to explore the metric concepts they would miss by coming into the program upstream. Students have utilized the Metric Systems for, at most, two years.

The Zone One Tests

Although teachers in the zone did not blame the test instruments for any particular failures which their students experienced, the difficulty level of the Division II items still may be influencing the lower achievement figures reported there.

For the most part the items appear to have been well referenced to objectives in the program of studies. However, when compared to some of the instruments used in assessment (British Columbia and Alberta) and standardized testing (Canadian Test of Basic Skills), the Zone One items seem to be more demanding. Multiple choice items were all but non-existent and the many complicated completion type items, particularly at the Division II level, were more open to computational error.

Also, the test instruments were to be diagnostic in nature; however, the clustering of the individual items for analysis of achievement by objective decreased the diagnostic value of the tests. Rather than being able to pinpoint a specific weakness such as the students' ability to identify the zero (0) as a place holder, the deficiency would only be regarded as a lack of place value or operational understanding.

Regardless of any particular weakness which may be directed at the instruments used in this study, the questionnaire data does support the validity of the tests upon which this study was based. According to the teachers the Zone One instruments were valid for the purposes of assessing student understanding and for evaluating the elementary mathematics program.

IMPLICATIONS FOR THE CURRICULUM

Some of the difficulties that appear to thread through the scope and sequence of mathematics objectives, grades one to six, may be due to particular weaknesses within the program and/or with the inadequacies of the implementation process. It was not the

intention of this study to delineate the causes so much as to find out if and where problems do exist. However, it is possible to speculate about some of the apparent weaknesses that could influence the opportunities that children have to learn the mathematics that is intended for them.

One important consideration is that it does not appear to be sufficient to simply list the objectives within the strands and expect that the proper sequencing will be managed. Unless the textbooks do a better job of covering the content they alone cannot provice the necessary bridging and spacing of the elementary mathematics content.

Pupil achievement in the area of place value may be an indication that methodology is not to be ignored. If the skills associated with place value are handled primarily in the abstract and in conjunction with the operations, students will likely continue to be frustrated.

Along this same line, the weaknesses that are associated with the money objectives may be in part due to their treatment in isolation from the supporting objectives in the Number and the Operations and Properties strands. Low performances on objectives in graphing may in part also be due to this isolative factor.

The suggestio made in the Elementary Mathematics Handbook (1977) in relation to the importance of problem solving should be taken seriously. If it is as indicated "a unifying process which permeates all the strands of the program" (p. 21), then perhaps it should be given more attention. Perhaps the topic of problem solving is important enough to have its own scope and sequence.

Perhaps the topics within the other strands could be developed within the context of problem solving rather than the reverse.

There seems to be some lack of agreement as to the importance of immediate recall of basic facts in the elementary mathematics program. Memorization should continue as a significant instructional objective along with that of understanding. However, teachers may be receiving inconsistent communication as to the appropriate emphasis for each.

RECOMMENDATION FOR FURTHER RESEARCH

One major recommendation would be to reconsider the scope and sequence of the current program of studies for elementary school mathematics. Hopefully what would emerge is a more detailed plan that would pay more careful attention to sequencing in particular.

The diagnostic aspect of this study did not pinpoint for the teachers the specific problems which hinder student achievement in elementary school mathematics. The next step to a study such as this could be the development of programs to help teachers better diagnose the isolated mistakes and patterns of errors that children make and then to help build plans for the necessary corrective action.

Research should be conducted into the reasons why Zone One students have so much difficulty with problem solving.

There is also room for more study into the curriculum and instruction of the Metric System of measurement within the elementary grades. More information is available now than was at the time of the program development in 1975 and 1976.

The above comment may also apply to the topic of transformational geometry although the main concern here is perhaps with the concepts and where they are to extend in subsequent geometry programs.

Another area that should be investigated is the degree to which teachers are able, through preparation or formal training, to diagnose pupil errors in mathematics and to prescribe effective treatment strategies to the difficulties revealed.

Finally, it should be noted that one important area that this study failed to explore is that of the affective realm of the student. The feelings and attitudes of these children may turn out to be highly significant.

APPENDIX A

THE STUDENT ANALYSIS FORM - 1978

School System _____

School _____

xi (a)

GRADE FIVE MATHEMATICS TEST

STUDENT ANALYSIS FORM - PAGE 1

Name: _____ Grade 5 Male or Female _____ Birthdate: _____

- PART I -

QUESTION BASIS		
NO..	POSSIBLE	ACTUAL
1	20	
2	20	
3	8	
4	6	
5	20	
6	16	
7	10	
8	6	
9	8	
10	6	
11	6	
12	4	
13	4	
14	6	
15	6	
16	8	
17	8	
18	6	
19	6	
20	6	
21	4	
22	4	
23	4	
24	4	
Total	196	

OBJECTIVE BASIS

NUMBER STRAND

OBJ.	CORRS. QUES.	POSSIBLE	ACTUAL
1	1	20	
2	2	20	
3	3, 4	14	
4	5	20	
5	6	16	
6	7, 8	16	
TOTAL:		106	

OPERATIONS AND PROPERTIES STRAND

OBJ.	CORRS. QUES.	POSSIBLE	ACTUAL
1	9	8	
2	10	6	
3	11	6	
4	12, 13	8	
5	21,22,23,24	16	
6	14,15,16,17	28	
7	18, 19, 20	18	
TOTAL:		90	

School System _____

School _____

GRADE FIVE MATHEMATICS TEST

STUDENT ANALYSIS FORM - PAGE 2

xi (b)

Name: _____ Grade 5 Male or Female _____ Birthdate: _____

- P A R T II -

QUESTION BASIS		
NO.	POSSIBLE	ACTUAL
1	1	
2	1	
3	4	
4	3	
5	4	
6	3	
7	2	
8	3	
9	4	
10	6	
11	1	
12	2	
13	4	
14	4	
15	4	
16	4	
17	2	
18	2	
19	8	
20	8	
21	3	
22	2	
23	2	
24	3	
25	3	
26	3	
27	3	
28	3	
29	4	
30	4	
31	4	
TOTAL	104	

OBJECTIVE BASIS

MEASUREMENT STRAND

OBJ.	CORRS. QUES.	POSSIBLE	ACTUAL
1	1, 2	2	
2	3	4	
3	4	3	
4	5	4	
5	6	3	
6	7	2	
7	8, 9	7	
8	10	6	
9	11, 12, 13	7	
10	14	4	
TOTAL:		42	

GEOMETRY STRAND

OBJ.	CORRS. QUES.	POSSIBLE	ACTUAL
1	15,16,17,18	12	
2	19	8	
3	20	8	
4	21, 22, 23	7	
TOTAL:		35	

GRAPHING STRAND

OBJ.	CORRS. QUES.	POSSIBLE	ACTUAL
1	24, 25, 26	9	
2	27, 28	6	
3	29	4	
4	30	4	
5	31	4	
TOTAL:		27	

GRAND TOTAL _____ ÷ 3 = PERCENTAGE _____

APPENDIX B

THE ANSWER SHEET - 1979

SIDE 2

PART II (GRADE FOUR USE THIS SIDE FOR PART III AND IV)

STUDENT PROFILES WILL BE MADE FROM THESE ANSWER SHEETS—PLEASE CHECK THEM

EXAMPLES

SCORE OF 5 OUT OF 9	SCORE OF 17 OUT OF 20
A	B
7	17

1 2 3 4 5 6 7 8 9 10 11

12 13 14 15 16 17 18 19 20 21 22 23 24

25 26 27 28 29 30 31 32 33 34 35 36 37

32

ZONE ONE
ELEMENTARY MATHEMATICS TESTS
ANSWER SHEETS

EXAMPLES

1 2 3 4

WRONG WRONG WRONG RIGHT

IMPORTANT DIRECTIONS FOR MARKING ANSWERS

- Use black lead pencil only (Hb or softer)
- DO NOT use ink or ballpoint pens
- Make heavy black marks that fill the circle completely
- Erase cleanly any answer you wish to change
- Make no stray marks on the answer sheet

28

IMPORTANT

- Please use the Direction pages to record your school system, school, Early and Late codes and student name.
- After correcting student tests use the Answer Key and Teachers Guide to accurately transfer the one or two digit responses to this sheet.
  Example: For questions with one digit totals fill in only the ones column. For questions with two digit totals use the tens and the ones column.

EXAMPLES

FOR A SCORE OF 4 OUT OF 5	FOR A SCORE OF 8 OUT OF 20
A	B
4	8

33

SCHOOL SYSTEM NUMBER

SCHOOL NUMBER

GRADE

SEX
MALE
FEMALE

EARLY OR LATE STARTERS
EARLY
LATE

STUDENT NAME (Last, First)

29

34

NCS Trans-Optic 08-6874:84321

ZONE ONE
ELEMENTARY MATHEMATICS TESTS

SIDE 1
ANSWER SHEET

SEE IMPORTANT MARKING INSTRUCTIONS ON SIDE 2

PART I

(GRADE FOUR USE THIS SIDE FOR PARTS I AND II)

EXAMPLES

A SCORE OF 5 OUT OF 8	A SCORE OF 8 OUT OF 20
A	B
NO ZERO REQUIRED	USE ZERO'S HERE

1 2 3 4 5 6 7 8 9 10 11

12 13 14 15 16 17 18 19 20 21 22 23 24

25 26 27 28 29 30 31 32 33 34 35 36 37

NOTE: THIS ANSWER SHEET IS USED FOR ALL GRADES (1–6).
EACH TEST WILL REQUIRE A DIFFERENT NUMBER OF ANSWER SPACES.

2

35

APPENDIX C

THE QUESTIONNAIRE

THE ZONE ONE ELEMENTARY

MATHEMATICS TESTING PROJECT

QUESTIONNAIRE

(Following the working paper on Mastery Learning)

November, 1978

Please return to:

Alberta Education
Field Services Branch
500 Nordic Court
10014 - 99 Street
Grande Prairie, Alberta
T8V 3N4

THE ZONE ONE ELEMENTARY

MATHEMATICS TESTING PROGRAM

Questionnaire

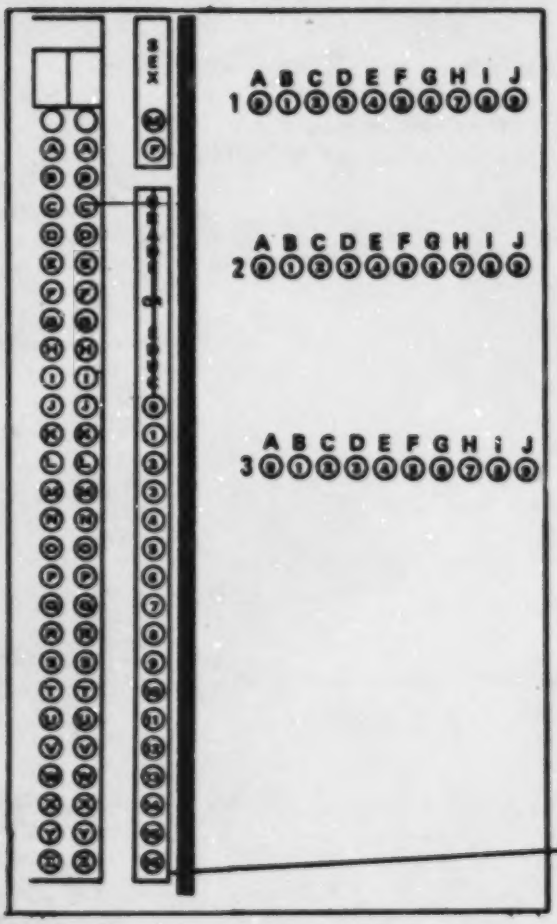
The purpose of this questionnaire is to obtain your perceptions about the mathematics achievement of students in your school system and the zone. I would appreciate your helping out in this exercise.

NOTE: (1) The objectives referred to in this questionnaire are those specifically outlined in the 1977 Elementary Mathematics Curriculum Guide.

(2) Please send the questionnaire to the Regional Office by December 15. They have been directed to hold all forms and to ship them in one group; individual anonymity will be preserved in this way. Would you kindly supply the additional information requested below.

(3) Please place answers to Questions on the Answer Sheet. Use pencil to record your responses and return only the Answer Sheet.

GENERAL PURPOSE — NCS — ANSWER SHEET



1. Pencil in the grade you teach. e.g. ⑥ Six
   If you teach more than one grade choose only one and use it consistently throughout this questionnaire.

2. Pencil in the number (e.g. ⑤ five) that represents the number of years you have taught in Zone I elementary schools.
   ① indicates 1st year - ⓪ means in your tenth year or more.

3. Pencil in the number that represents the total number of years you have been teaching.
   ① indicates 1st year - ⓪ means in your tenth year or more.

Use this column to record your school system code. The one you used for the Zone I Testing Project. e.g. County of Grande Prairie 01 - record only 1. The zero's are not required here.

Questionnaire Page 2

I. Below is a list of possible factors, labeled four (4) through eleven (11) that might influence the opportunities students have to achieve mastery (85% or above) levels on the elementary mathematics objectives.

4. There is a lack of good materials for teaching certain objectives.

5. Textbooks do not match the program objectives.

6. The program objectives for my grade level are too difficult.

7. The test items for my grade level are too difficult.

8. The varied abilities of my students makes instruction difficult.

9. The sequencing of content in our textbook is inappropriate.

10. Keeping track of failure and successes and subsequent follow-up is too difficult.

11. Students fail to master objectives because of inadequate learning skills (e.g., forgetting).

Please rank each of factors 4 through 11 as follows. From one (1) the factor you think most likely explains why students in your system did not master the mathematics objectives, to eight (8), the factor you think least likely explains why students did not master the mathematics objectives (below 85%) (omit the zero (0))

NOTE: - only 8 factors.

	A	B	C	D	E	F	G	H	I	J
4	0	1	2	3	4	5	6	7	8	9
5	0	1	2	3	4	5	6	7	8	9
6	0	1	2	3	4	5	6	7	8	9
7	0	1	2	3	4	5	6	7	8	9
8	0	1	2	3	4	5	6	7	8	9
9	0	1	2	3	4	5	6	7	8	9
10	0	1	2	3	4	5	6	7	8	9
11	0	1	2	3	4	5	6	7	8	9

e.g. second most likely . . .

e.g. if you think 6 is the most likely factor, pencil in (1).

e.g. if you think 9 least likely explains, pencil in (8).

II. The following factors might be those which would contribute to a successful mathematics program in any school. (Factors labeled 12-18 for answer sheet purposes only.)

12. A instructional plan involving good teachable materials.

13. Textbooks that students like and which cover the program objectives.

14. A management plan that includes help for marking and ways and means of keeping track and following up with students.

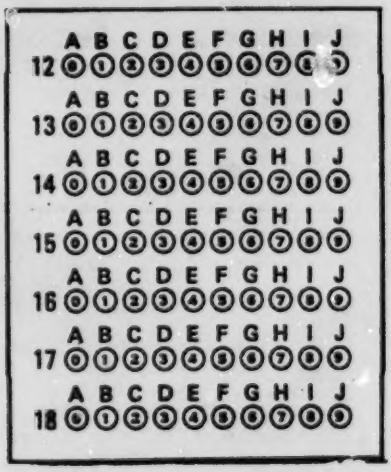
15. A program that is geared to the ability levels of all children.

16. A classroom of children grouped so that their needs, abilities and interests are alike.

17. The professional training of the teachers in our system.

18. The continuous (inservice) education of teachers in our system in mathematics.

Please rank factors 12 through 18 as follows. From one (1) the factor you think is the most important contributor for a successful mathematics program to seven (7) the factor you think is the least important for a successful mathematics program. (Omit the zero (0).)



III. The third section of this questionnaire deals with the composite achievement scores of students at the Zone One level. For your reference the lowest non-mastery scores are recorded for objectives under each of the five strands, grades one to six. The concept areas are abbreviated also. Answer the questions which follow only for the grade you teach.

Grade One

Number	Oper. & Prop.	Measurement	Geometry	Graphing
5.Actually tests objective 6.renaming 72.7%	2.Symbolizes addit. & subt. sit. 73.9%	6.Recognizes coins & other values 68.3%	Mastery	1.Graphing data 78.6%

Grade Two

Number	Oper. & Prop.	Measurement	Geometry	Graphing
5.place value 65.1%	5.Solves picture & word problems 50.0%	4.Months in order 49.2%	3.Geometric pattern 75.0%	1.Construct bar & pictograph 69.4%

Grade Three

Number	Oper. & Prop.	Measurement	Geometry	Graphing
4.place value 45.4	9.solves word problems 56.0%	9.linear meas. to tenths 38.2%	4.Corresponding parts 48.8%	1.the axis 48.1%

Grade Four

Number	Oper. & Prop.	Measurement	Geometry	Graphing
8.tenths hundredths 9.6%	3.Rounding 37.0%	9.linear meas. to hundredths 12.8%	2.Axis of symmetry 44.4%	4.ordered pairs 45.6%

Grade Five

Number	Oper. & Prop.	Measurement	Geometry	Graphing
3.place value to 0.001 36.4%	6.Solve word problems 35.0%	9.equivalent measures 27.2%	2.Corresponding parts 38.2%	4.radius diam. & circumferences 41.8%

Grade Six

Number	Oper. & Prop.	Measurement	Geometry	Graphing
3.decimals & expanded notation 40.1%	6.Mult. & divides decimals 35.5	6.interrelationships 25.9	3.Constructs 3-D figures 43.7	2.ordered pairs 59.9

Questionnaire Page 5

The following factors are those which may have contributed to the non-mastery status of Zone I students who, taken together, contributed to the lowest scores on the indicated objectives.

A. Students traditionally have difficulty with this topic.

B. The topic is new. Understanding will grow with teacher familiarity.

C. Students have not mastered previous concepts upon which this concept is dependent.

D. Instructional materials are lacking in this area.

E. This topic would not receive the instructional emphasis required for mastery.

F. This concept is beyond the ability of children at this particular grade level.

Which of the above factors do you think best explains the lowest Zone I scores in each of the five strands as outlined below. (Answer for the grade level you recorded in item one.)

19. Number

A B C D E F G H I J
⓪①②③④⑤⑥⑦⑧⑨

Pencil in your choice of factors A, B, C, D, E, or F.
e.g. ⓪ ① ② ③ ④ ⑤

20. Operations and Properties

A B C D E F G H I J
⓪①②③④⑤⑥⑦⑧⑨

21. Measurement

A B C D E F G H I J
⓪①②③④⑤⑥⑦⑧⑨

22. Geometry

A B C D E F G H I J
⓪①②③④⑤⑥⑦⑧⑨

23. Graphing

A B C D E F G H I J
⓪①②③④⑤⑥⑦⑧⑨

A P P E N D I X D

A SUPPLEMENTARY PRINT-OUT FOR THE CENTRAL OFFICES - GRADE FOUR

ZONE ONE

COORDINATOR
AL ANDERSON
5804 - 109th AVENUE
EDMONTON, ALBERTA
T6A 1S2

elementary MATHEMATICS TESTING PROJECT

PERCENTAGE MEANS FOR ZONE

ZONE ONE GRADE FOUR JUNE/79

NUMBER		OPERATIONS & PROPERTIES		MEASUREMENT		GEOMETRY		GRAPHING	
1	58.7%	1	61.2%	1	63.4%	1	75.6%	1	83.9%
2	53.8%	2	43.3%	2	52.8%	2	56.2%	2	79.1%
3	50.3%	3	43.1%	3	31.6%	3	58.7%	3	64.9%
4	79.8%	4	54.4%	4	52.6%			4	49.8%
5	45.6%	5	54.0%	5	58.8%				
6	60.2%	6	70.5%	6	60.7%				
7	57.9%	7	41.3%	7	64.1%				
8	16.2%	8	49.7%	8	45.7%				
9	49.8%	9	64.0%	9	21.8%				
		10	81.0%						
AVG	52.5%		56.2%		50.2%		63.5%		69.5%

PERCENTAGE MEANS FOR ZONE

OUT OF ZONE GRADE FOUR JUNE/79

NUMBER		OPERATIONS & PROPERTIES		MEASUREMENT		GEOMETRY		GRAPHING	
1	61.8%	1	67.7%	1	64.7%	1	76.5%	1	87.9%
2	57.0%	2	47.5%	2	57.3%	2	54.6%	2	80.9%
3	55.7%	3	43.0%	3	30.3%	3	64.9%	3	66.9%
4	83.1%	4	62.3%	4	59.9%			4	51.7%
5	48.8%	5	65.2%	5	66.9%				
6	65.1%	6	80.1%	6	70.9%				
7	65.1%	7	50.0%	7	65.3%				
8	15.4%	8	60.0%	8	53.6%				
9	51.0%	9	70.2%	9	13.4%				
		10	85.2%						
AVG	55.9%		63.1%		53.6%		65.3%		71.8%

COMPARING MASTERY LEVELS OF MALES AND FEMALES

ZONE ONE GRADE FOUR JUNE/79

NUMBER		OPERATIONS & PROPERTIES		MEASUREMENT		GEOMETRY		GRAPHING	
1M	57.6%	1M	57.9%	1M	62.8%	1M	73.8%	1M	83.6%
F	59.9%	F	65.0%	F	64.0%	F	77.8%	F	84.4%
2M	51.7%	2M	40.8%	2M	54.7%	2M	56.0%	2M	77.3%
F	56.2%	F	46.0%	F	50.7%	F	56.4%	F	81.3%
3M	51.5%	3M	41.8%	3M	32.8%	3M	57.7%	3M	63.5%
F	49.0%	F	44.5%	F	30.3%	F	59.9%	F	66.6%
4M	77.8%	4M	51.4%	4M	52.4%			4M	49.5%
F	82.0%	F	57.7%	F	52.7%			F	50.2%
5M	43.5%	5M	52.7%	5M	59.1%				
F	47.9%	F	55.6%	F	58.3%				
6M	59.2%	6M	67.1%	6M	59.9%				
F	61.3%	F	74.2%	F	61.6%				
7M	54.0%	7M	39.9%	7M	64.9%				
F	62.3%	F	42.9%	F	63.2%				
8M	14.8%	8M	48.3%	8M	45.2%				
F	17.9%	F	51.3%	F	46.3%				
9M	48.0%	9M	58.8%	9M	21.5%				
F	51.8%	F	69.9%	F	22.2%				
		10M	78.9%						
		F	83.3%						
AVM	50.9%	M	53.8%	M	50.4%	M	62.5%	M	68.4%
L	54.3%	F	59.8%	F	49.9%	F	64.7%	F	70.6%

COMPARING MASTERY LEVELS OF MALES AND FEMALES

OUT OF ZONE GRADE FOUR JUNE/79

NUMBER		OPERATIONS & PROPERTIES		MEASUREMENT		GEOMETRY		GRAPHING	
1M	61.2%	1M	66.2%	1M	68.3%	1M	73.2%	1M	87.6%
F	62.6%	F	69.5%	F	60.4%	F	80.8%	F	88.2%
2M	52.9%	2M	45.6%	2M	59.3%	2M	51.6%	2M	78.5%
F	61.8%	F	49.7%	F	55.0%	F	58.2%	F	83.8%
3M	59.0%	3M	39.5%	3M	32.8%	3M	62.3%	3M	66.8%
F	51.8%	F	47.0%	F	27.3%	F	67.9%	F	66.9%
4M	80.4%	4M	60.1%	4M	63.1%			4M	52.1%
F	86.2%	F	68.0%	F	56.2%			F	51.3%
5M	47.9%	5M	64.1%	5M	66.9%				
F	49.8%	F	66.5%	F	66.8%				
6M	63.0%	6M	77.8%	6M	69.8%				
F	67.6%	F	82.8%	F	72.3%				
7M	61.0%	7M	49.1%	7M	68.4%				
F	69.9%	F	51.1%	F	61.7%				
8M	16.7%	8M	59.1%	8M	53.6%				
F	13.9%	F	61.1%	F	53.5%				
9M	53.2%	9M	66.1%	9M	13.0%				
F	48.5%	F	75.0%	F	13.9%				
		10M	84.7%						
		F	85.7%						
AVM	55.0%	M	61.2%	M	56.0%	M	62.3%	M	71.2%
L	56.9%	F	65.3%	F	51.9%	F	68.9%	F	72.6%

COMPARING MASTERY LEVELS OF EARLY AND LATE STARTERS

ZONE ONE GRADE FOUR JUNE/79

	NUMBER		OPERATIONS & PROPERTIES		MEASUREMENT		GEOMETRY		GRAPHING
1E	57.1%	1E	59.7%	1E	62.5%	1E	73.7%	1E	82.1%
L	63.5%	L	64.5%	L	66.2%	L	79.0%	L	87.5%
2E	51.2%	2E	40.5%	2E	51.7%	2E	53.1%	2E	76.9%
L	58.7%	L	49.3%	L	55.8%	L	60.7%	L	82.9%
3E	48.4%	3E	41.1%	3E	29.7%	3E	57.0%	3E	62.0%
L	54.8%	L	47.3%	L	35.1%	L	61.9%	L	70.6%
4E	78.9%	4E	53.1%	4E	51.6%			4E	46.9%
L	81.9%	L	57.0%	L	54.7%			L	54.2%
5E	42.2%	5E	51.7%	5E	56.8%				
L	51.4%	L	58.7%	L	62.3%				
6E	57.9%	6E	68.6%	6E	58.3%				
L	65.6%	L	74.1%	L	65.1%				
7E	56.6%	7E	39.6%	7E	62.1%				
L	61.0%	L	44.8%	L	67.7%				
8E	13.4%	8E	47.5%	8E	44.2%				
L	22.3%	L	53.8%	L	48.8%				
9E	46.1%	9E	61.2%	9E	19.7%				
L	57.2%	L	69.6%	L	24.3%				
		10E	80.2%						
		L	83.0%						
AVE	50.2%	E	54.3%	E	48.5%	E	61.3%	E	67.0%
L	57.4%	L	60.2%	L	53.3%	L	67.2%	L	73.8%

COMPARING MASTERY LEVELS OF EARLY AND LATE STARTERS

OUT OF ZONE GRADE FOUR JUNE/79

	NUMBER		OPERATIONS & PROPERTIES		MEASUREMENT		GEOMETRY		GRAPHING
1E	60.5%	1E	67.3%	1E	62.3%	1E	73.8%	1E	86.8%
L	63.5%	L	68.0%	L	68.2%	L	80.4%	L	89.5%
2E	56.9%	2E	48.3%	2E	56.2%	2E	54.6%	2E	80.3%
L	57.5%	L	46.7%	L	59.0%	L	54.2%	L	81.8%
3E	51.8%	3E	42.2%	3E	29.5%	3E	64.1%	3E	65.5%
L	61.5%	L	44.3%	L	31.7%	L	66.0%	L	68.5%
4E	83.0%	4E	61.4%	4E	60.1%			4E	52.6%
L	83.0%	L	63.8%	L	59.8%			L	50.5%
5E	45.9%	5E	64.1%	5E	66.3%				
L	53.5%	L	66.6%	L	68.1%				
6E	64.1%	6E	79.5%	6E	70.6%				
L	66.2%	L	80.9%	L	71.8%				
7E	64.1%	7E	50.6%	7E	64.1%				
L	66.4%	L	49.3%	L	67.4%				
8E	14.3%	8E	57.0%	8E	54.0%				
L	17.2%	L	64.4%	L	53.0%				
9E	51.1%	9E	70.1%	9E	12.9%				
L	51.3%	L	70.0%	L	14.3%				
		10E	83.6%						
		L	87.2%						
AVE	54.6%	E	62.4%	E	52.9%	E	64.2%	E	71.3%
L	57.8%	L	64.1%	L	54.8%	L	66.9%	L	72.6%